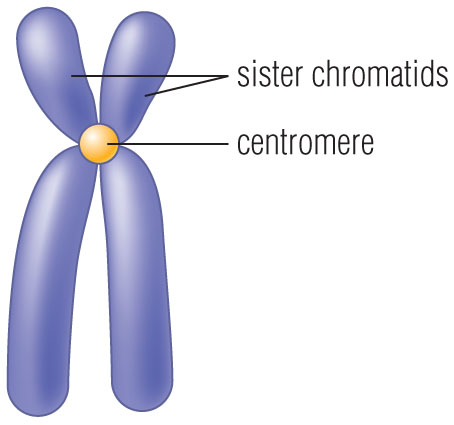
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**Unit 5 Review Packet: Cell Division**

Ms. Ottolini, PreAP Biology

1. Draw a chromosome. Label the sister chromatids and centromere.



1. Why does chromatin coil up into chromosomes in preparation for mitosis?

Chromatin (uncoiled DNA) coils up into chromosomes because it is easier to split the identical copies of DNA when they are coiled. During mitosis, identical copies of coiled DNA (must be split) to send a full copy of DNA to each daughter cell.

1. When does DNA replication occur during the cell cycle?

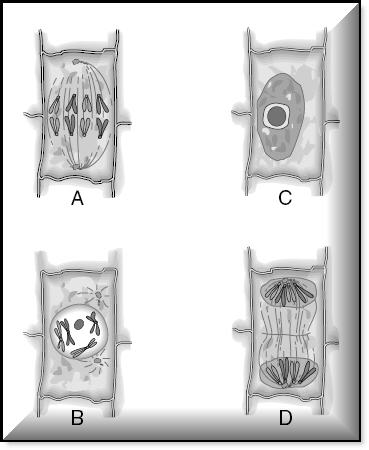
DNA replication occurs during the S (synthesis) stage of interphase.

1. Why does DNA replication have to occur before cell division?

DNA replication must occur before cell division so that each daughter cell has a full copy of DNA.

1. When do normal cell activities (ex: growth) occur during the cell cycle?

Normal cell activities occur during the G1 stage of interphase.



1. Explain what is occurring in each image shown to the right. Make sure to include the NAME of each stage of the cell cycle/mitosis.

A: Anaphase – Sister chromatids separate and are pulled to opposite ends of the dividing cell by spindle fibers.

B: Prophase – Chromatin coils up into chromosomes, the nuclear membrane and nucleolus begin to break down, and the mitotic spindle begins to form.

C: Interphase – DNA is uncoiled as chromatin and the nuclear membrane / nucleolus are intact.

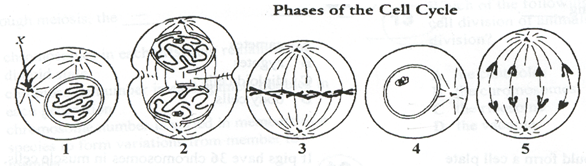
D: Telophase – Chromosomes uncoil into chromatin, two nuclear membranes and nucleoli form around daughter cell DNA, and the mitotic spindle breaks down.

AND… Cytokinesis – a cell plate forms between the two daughter plant cells to split the cytoplasm and organelles

Note: Metaphase (in which chromosomes are pushed to the center of the dividing cell by mitotic spindle fibers) is not shown in this image.

1. What is the correct order of the images shown to the right?

C (Interphase), B (Prophase), A (Anaphase), D (Telophase and Cytokinesis)



1. Explain what is occurring in each image shown above. Make sure to include the NAME of each stage of the cell cycle/mitosis.

1: Prophase – Chromatin coils up into chromosomes, the nuclear membrane and nucleolus begin to break down, and the mitotic spindle begins to form.

2: Telophase – Chromosomes uncoil into chromatin, two nuclear membranes and nucleoli form around daughter cell DNA, and the mitotic spindle breaks down.

AND… Cytokinesis – the cell membrane pinches in to form a cleavage furrow between animal daughter cells to split the cytoplasm and organelles

3: Metaphase – Chromosomes are pushed to the center of the dividing cell by mitotic spindle fibers.

4: Interphase – DNA is uncoiled as chromatin and the nuclear membrane / nucleolus are intact.

5: Anaphase – Sister chromatids separate and are pulled to opposite ends of the dividing cell by spindle fibers.

1. What is the correct order of the images shown on the previous page?

4 (Interphase), 1 (Prophase), 3 (Metaphase), 5 (Anaphase), 2 (Telophase and Cytokinesis)

1. Why does Ms. Ottolini say that telophase is like “reverse prophase?”

In this phase of mitosis, the cell is ending division, whereas the cell is preparing for division during prophase. During prophase the spindle forms, and during telophase the spindle breaks down. During prophase the chromatin coils into chromosomes, and during telophase the chromosomes uncoil into chromatin. During prophase the nuclear membrane and nucleolus break down, and during telophase, two nuclear membranes and nucleoli form around the daughter cell DNA.

1. Why do scientists believe that centrioles (i.e. the “churro-shaped” structures found inside the centrosome) are not directly involved in the formation of the mitotic spindle? (Instead, the “sun-like” structure surrounding the centrioles called the centrosome is primarily responsible for the formation of the mitotic spindle.)

Centrioles are only found in animal cells, but the mitotic spindle forms in both plant and animal cells. The centrosome is found in both animal and plant cells, so scientists think that it plays a more direct role in the creation of the spindle.

1. What is the main purpose of mitosis in eukaryotic single-celled organisms (ex: protists like amoebas)? How is this process different from binary fission in prokaryotic cells (ex: bacteria)?

Mitosis is used for reproduction in eukaryotic single-celled organisms. Binary fission is the process used for reproduction in prokaryotic organisms, but it is much simpler than mitosis because there is less DNA in a prokaryotic cell. In binary fission, DNA does not need to coil into chromosomes. Instead the single, circular loop of DNA is copied and the cell splits so that each daughter cell contains one loop of DNA. There is no mitotic spindle needed for this process.

1. What are the purposes of mitosis in eukaryotic multicellular organisms (ex: plants and animals)?

In multicellular organisms, mitosis is used for repair of damaged cells and growth.

1. What is the purpose of meiosis?

Meiosis is used to create sex cells (gametes), each with 23 chromosomes. The female gamete (egg) meets with the male gamete (sperm) during sexual reproduction.

1. A blood cell in a chicken contains 78 chromosomes. How many chromosomes will a chicken sperm cell contain?

A chicken sperm cell will contain 39 chromosomes (half the chromosomes found in a normal body cell).

1. An egg cell in a cow contains 30 chromosomes. How many chromosomes will a cow nerve cell contain?

A nerve cell (a type of body cell) will contain 60 chromosomes (twice the chromosomes found in a sex cell).

1. In what organ does meiosis (aka oogenesis) in human females occur?

The ovaries.

1. In what organ does meiosis (aka spermatogenesis) in human males occur?

The testes.

1. How are oogenesis and spermatogenesis different?

Oogenesis produces one functional egg cell and three polar bodies that will later disintegrate and die. Spermatogenesis produces four functional sperm cells.

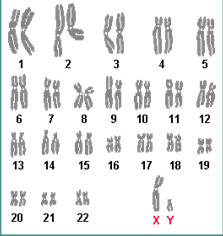
1. Why are three polar bodies and only one functional egg cell created during oogenesis?

The egg cell has more cytoplasm and organelles than the three polar bodies so that it can bring enough nutrients to the zygote (fertilized egg). (Note: Cytokinesis must occur unevenly during meiosis I and meiosis II to create an egg with a much higher amount of cytoplasm than the three polar bodies.)

1. When during meiosis does crossing over occur? What happens during crossing over?

Crossing over occurs during prophase I of meiosis. Pairs of homologous chromosomes exchange sections of DNA. Homologous chromosomes are pairs of chromosomes with the same types of genes (ex: eye color gene) in the same places.

1. What is the purpose of crossing over?



Crossing over occurs differently every time mitosis takes place, ensuring that no two sperm or eggs created by one individual are identical. This means that no two babies created by the same parents are exactly the same (unless they are identical twins). This is the reason why you look different from your siblings.

1. What is a karyotype? How is the last chromosome pair shown in the karyotype to the right different from the other chromosome pairs?

A karyotype is an image showing all the chromosomes in a single human body cell arranged by homologous pair. The first 22 pairs of chromosomes are called autosomes, and they contain DNA / genes that control normal body traits. The last pair of chromosomes are called sex chromosomes, and they contain DNA / genes that control secondary sex characteristics (ex: deep voice in males and lack of facial hair in women). Men have an X and a Y sex chromosomes (XY), whereas women have two X chromosomes (XX).

1. What is nondisjunction? How is nondisjunction related to Down syndrome (aka trisomy 21)?

Nondisjunction occurs when pairs of homologous chromosomes do not separate properly during meiosis (let’s say we’re talking about spermatogenesis in this example), resulting in one sperm cell containing both copies of the homologous chromosomes and the other sperm cell containing zero copies. If this sperm cell meets with a normal egg cell (with one copy of the homologous chromosome) during fertilization, this will create a zygote (fertilized egg) with three copies of the homologous chromosome. Once the zygote divides by mitosis to create multicellular embryo and eventually a baby, every cell within the embryo / baby will have three copies of that homologous chromosome. For example, babies with Down syndrome (aka trisomy 21) have three copies of the 21st homologous chromosome pair in each of their cells.

1. How is meiosis I different from meiosis II? Which process is most similar to mitosis? (Explain your answer!)

During metaphase I, homologous chromosomes line up in pairs along the metaphase plate. When these pairs of chromosomes separate during anaphase I, this results in daughter cells with half the number of chromosomes as the original parent cell. During metaphase II, chromosomes line up single file along the metaphase plate. During anaphase II, the sister chromatids (identical copies of DNA) in each chromosome are ripped apart. This results in daughter cells with the same number of chromosomes as the original parent cell (just with one chromatid each). Meiosis II is most similar to mitosis because chromosomes line up single file in both processes and sister chromatids are separated. Also, daughter cells have the same number of chromosomes as the original parent cell.

1. Why do eggs and sperm need to be haploid cells? Use the terms meiosis and fertilization in your answer.

Meiosis creates eggs and sperm that are haploid cells with one set of chromosomes each (23 chromosomes in humans). Eggs and sperm come together during fertilization to create a diploid zygote (fertilized egg) with 46 chromosomes. That zygote divides by mitosis to create a multicellular embryo and eventually a baby with 46 chromosomes in each body cell.

1. Fill in the information in the columns below to compare characteristics of mitosis and meiosis.

|  |  |  |
| --- | --- | --- |
| **Characteristic** | **Mitosis** | **Meiosis** |
| # of Divisions? | 1 | 2 |
| # of Daughter Cells? | 2 | 4 |
| Creation of Haploid or Diploid Cells? | Diploid | Haploid |
| # of Chromosomes in Human Daughter Cells? | 46 | 23 |
| Creation of Somatic Cells or Gametes? | Somatic Cells | Gametes |
| Type of Reproduction: Asexual, Sexual, or Both? | Asexual | Sexual |
| Used for Growth / Tissue Repair? (yes or no) | Yes | No |

1. How is cytokinesis different in plant vs. animal cells?

In plant cells, a new cell wall must form between the daughter cells. This new cell wall is called a cell plate. In animal cells, the cell membrane pinches in to form a cleavage furrow between the two daughter cells.

*Note: For the following three questions, refer to your “Why do cells need to divide? Worksheet”*

1. What happens to the surface area to volume ratio (represents the amount of cell membrane compared to the volume of a cell) as the size of a cell increases?

The surface area to volume ratio decreases as the size of a cell increases.

1. Which cell is able to transport materials most efficiently across its membrane—a small cell or a large cell?

A small cell transports materials more efficiently across its membrane because it has a higher surface area to volume ratio than a large cell. (Hence, it has more membrane compared to its volume than a large cell.)

1. Use your answer to the previous two questions to provide support for the following statement: “Cells cannot grow forever. Eventually they have to divide.”

When cells get too large, their surface area to volume ratios are too small (i.e. not enough membrane) for them to transport materials efficiently into and out of the cell. When they get too large for efficient transport across the membrane, they divide to create two smaller daughter cells.